

Corrigendum: On the dynamics of the Meissner effect (2016 Phys. Scr. 91 035801, arXiv:1508.03307)

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The paper erroneously assumed that the normal carriers giving rise to the backflow could be either electrons or holes.

PACS numbers:

On page 7 the paper read:

“As the phase boundary advances at rate $v_0 = dx_0/dt$, normal (negatively charged) carriers in the boundary layer are backflowing at speed v_0 , or equivalently positive normal carriers (holes) move forward together with the phase boundary. Because normal carriers scatter off the lattice they do not acquire a large v_y from the action of the magnetic Lorentz force; instead they transfer their y -momentum to the lattice as a whole, thus accounting for momentum conservation.”

The second half of that statement was incorrect. Similarly Figure 5 (reproduced below) and the last part of its caption that reads “The normal carriers do not acquire a large v_y in opposite direction because they scatter off impurities and transfer their y -momentum to the lattice.” was not correct.

The paper was in error in ignoring the fact that within the theory of hole superconductivity the normal state carriers in a superconductor are necessarily holes [1]. If the carriers are holes, electric and magnetic forces in the y direction are exactly balanced and the backflowing carriers move exactly in the x direction, with no velocity component in the y direction. The momentum transfer occurs through the flow of hole carriers and this accounts for momentum conservation *without scattering processes*, which is necessary to ensure the *reversibility* of the process. For more details, see Ref. [2–4]. A corrected Figure 5 is given below.

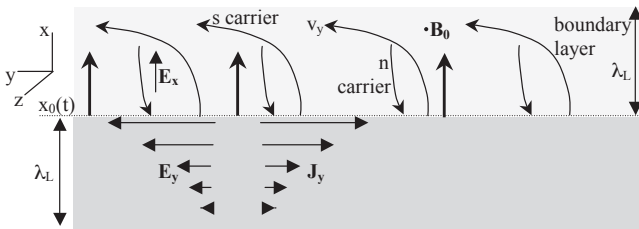


FIG. 5: (original) As carriers become superconducting (s carriers) they thrust forward into the normal region over a boundary layer of thickness λ_L , and are deflected by the Lorentz force acquiring speed $v_y = -c/(4\pi n_s q \lambda_L) B_0$. This process creates an electric field E_x in the $-\hat{x}$ direction that drives normal carrier (n carrier) backflow. Here, “n” stands both for “normal” and “negative”. The normal carriers do not acquire a large v_y in opposite direction because they scatter off impurities and transfer their y -momentum to the lattice.

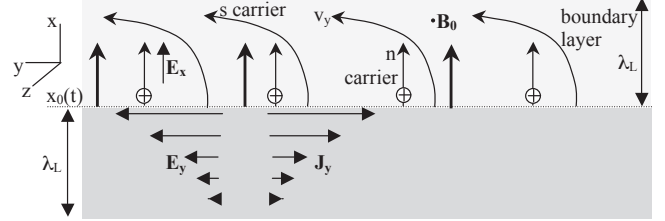


FIG. 5: (corrected): As carriers become superconducting (s carriers) they thrust forward into the normal region over a boundary layer of thickness λ_L , and are deflected by the Lorentz force acquiring speed $v_y = -c/(4\pi n_s q \lambda_L) B_0$. This process creates an electric field E_x in the $-\hat{x}$ direction that drives normal carrier (n carrier) backflow. Here, “n” stands for “normal” carrier. The normal carriers are *holes* [1] and they do not acquire any v_y but instead propagate exactly along the x direction, as explained in [2–4], and in the process transfer y -momentum to the lattice *without any scattering processes*.

The author is grateful to an insightful referee who stated in his/her report: “for the situation at hand here, where the system is clearly a many-body one, the states being those of an interacting and hence correlated Fermion assembly, what exactly is meant by a ‘hole’? Again, and specifically in the context of promulgating a quite different view of a reasonably well accepted standard model it appears incumbent on the author to provide a cogent summary (a few sentences at the least) by way of elucidation of a ‘hole theory’ actually is.”

The author responded to the referee’s suggestion: “In many papers listed in physics.ucsd.edu/~jorge/hole.html the key issue of holes versus electrons is addressed in detail, but it is not relevant to this paper and there is no reason to address it here.” That answer was incorrect. The key issue of holes versus electrons was highly relevant to this paper.

The answer to the referee’s query is contained in this erratum, which would have been unnecessary if the author had heeded the referee’s suggestion to clarify “what exactly is meant by a ‘hole’”. The answer is, as illustrated in the corrected figure 5: *a hole is a normal state carrier flowing in the direction of motion of the phase boundary in the reversible transition between normal and superconducting states. Because of its hole-like nature it propagates exactly perpendicular to the phase boundary without any velocity component in direction parallel*

to the phase boundary, which would render the transition irreversible in contradiction with experiment.

- [1] See references in <http://physics.ucsd.edu/~jorge/hole.html>.
- [2] Hirsch J E 2016 On the reversibility of the Meissner effect and the angular momentum puzzle, *Annals of Physics* **373**, 230.
- [3] Hirsch J E 2016 The disappearing momentum of the supercurrent in the superconductor to normal phase transformation, *Europhys. Lett.* **114**, 57001.
- [4] Hirsch J E 2016 Proposed experimental test of the theory of hole superconductivity, *Physica C* **525 - 526** 44.